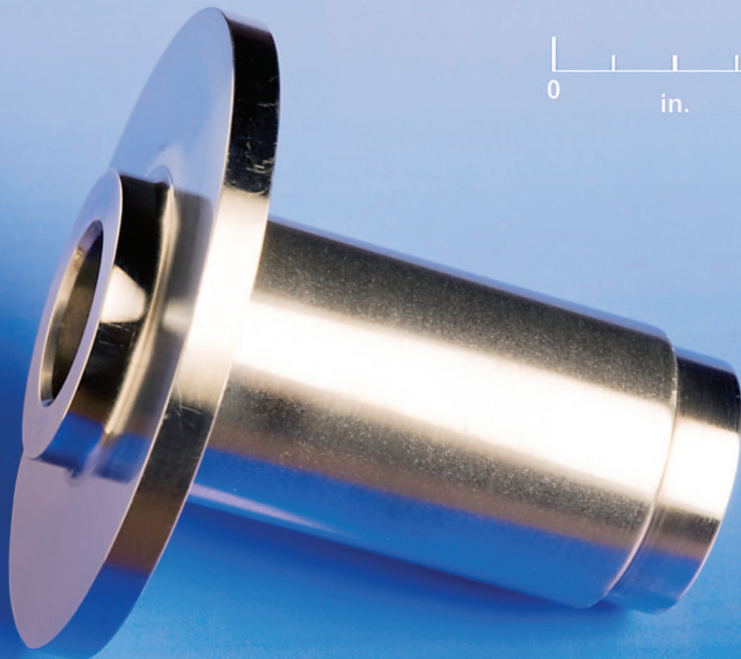
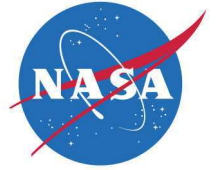


National Aeronautics and
Space Administration



Materials and Coatings

Oil-Free Turbomachinery Technologies

Creating a revolution in aircraft propulsion

NASA's Glenn Research Center has developed high-temperature solid lubricant materials suitable for foil gas bearings that enable the commercialization of a broad array of revolutionary Oil-Free gas turbines, compressors, blowers, motors, and other rotating machines that can operate from cryogenic to red-hot temperatures. These tribological (friction and wear) coatings and composite powder metallurgy material innovations have immediate and proven spinoff potential for high-temperature steam turbine control valves, exhaust gas recirculation (EGR) valves, articulating ducts and piping joints, and other industrial and aerospace applications.

BENEFITS

- ➔ PS300 and PS400 solid lubricant coatings provide reduced friction and wear to any lightly loaded sliding mechanism operating from cryogenic to 650 C
- ➔ PS300 coated shafts operating against foil bearings have logged well over 100,000 start-stop cycles without wearing out resulting in a truly maintenance-free bearing
- ➔ NASA PS300 coatings and PM300 powder metallurgy materials and related technology are freely available in the marketplace from licensed vendors
- ➔ The constituents (ingredients) used in NASA PS/PM 300 and 400 materials are nontoxic and thermochemically stable. They are not water-soluble and have a low environmental impact

technology solution

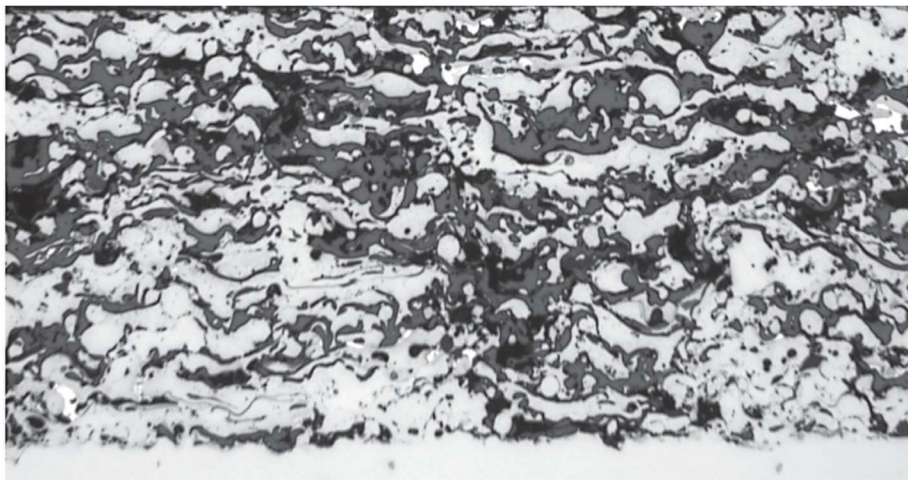


NASA Technology Transfer Program

Bringing NASA Technology Down to Earth

THE TECHNOLOGY

Oil-Free foil bearings require innovative approaches to solid lubrication for start-stop sliding contact that occurs before the gas lubricating film forms. The PS300 and PS400 coatings and their powder metallurgy cousins are composites from a unique combination of metals, ceramics, and solid lubricant additives. Plasma spray coating deposition is used to apply a thick (0.010 inch) layer onto a metal surface that is then ground and polished before use. During rubbing contact, the lubricant phases migrate to the surface forming a lubricious glaze that prevents wear and reduces friction. Powder metallurgy techniques are used to make freestanding self-lubricating components such as bushings and wear plates whenever a coating is not convenient or possible (e.g., inside small diameter parts). These materials are made from thermochemically stable, nonsoluble, nontoxic constituents and typically include nickel, molybdenum, chrome oxide, silver, and barium fluoride-calcium fluoride eutectic. Compositions can be easily tailored for specific applications. Operation of machinery using these tribomaterials has been proven over decades of use from subfreezing to over 650 C.



A PS400 cross-section control coating. The morphology is typical of plasma sprayed coatings and shows splat nature of constituent phases.

APPLICATIONS

The technology has several potential applications:

- ➔ PS300 coated shafts enable maintenance free, high-temperature Oil-Free microturbine electrical generators (
- ➔ PS300 used to lubricate high-temperature steam control valve lift rods in power plants worldwide for well over a decade and PM300 bushings provide long-life service in heat-treatment furnace conveyor systems
- ➔ PS400 coating (simplified composition) has a lower cost and is more dimensionally stable than predecessor PS300. PS400 has been proven durable in over 20,000 hours of turbine engine operation
- ➔ PS300/400 has direct applications to any high-temperature sliding contact. Automotive exhaust components such as recirculation (EGR) valves and aircraft bleed air valves, high-temperature ducting, and pipe

PUBLICATIONS

Patent No: 5,866,518; 8,182,741; 8377373; 8,753,417

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

LEW-16183-1, LEW-18476-1, LEW-18476-2, LEW-18561-1

